Title

Higher facial width-to-height ratio predicts fighting performance and perceived aggressiveness in MMA fighters

Authors

Vít Třebický[1], Jitka Fialová[1], Karel Kleisner[1], S. Craig Roberts[2], Anthony C. Little[2] & Jan Havlíček[1]

Addresses of Authors

1. Faculty of Science, Charles University; Viničná 7, 128 44 Prague 2, Czech Republic

2. School of Natural Sciences, University of Stirling; Stirling FK9 4LA, UK

Author for correspondence:

Vít Třebický, vit.trebicky@natur.cuni.cz

Summary

Previous studies have shown that facial width-to-height ratio (fWHR) is associated with sport performance, aggression and homicide. It has, however, been argued that the effect of fWHR might be a by-product of associations between size and behavioural measures. Here we tested whether fWHR and body measures are associated with perceived aggressiveness, fighting ability and success in physical confrontation in Mixed Martial Arts (MMA) fighters. Although perceived fighting ability was predicted by weight but not by fWHR, both fWHR and body weight independently predicted perceived aggressiveness. Furthermore, we found positive associations between fWHR and fighting performance, which appear independent of any effects of body size. Our results indicate that fWHR, as a testosterone-related morphological feature, is associated with fighting ability and perceived aggression, independently of body size, and that fWHR might therefore be considered a viable and reliable marker for inference of success in male intra-sexual competition.

Introduction

A growing body of evidence indicates an association between facial morphology and some aspects of human psychology. In particular, facial width to upper facial height ratio (fWHR) has been proposed as a trait used in competitor assessment. fWHR has been associated with anti-social behaviour [1,2], perceived aggressiveness [3,4] and aggressive behaviour [5,6], sport performance [7], strength [8], and the probability of being killed in violent physical encounters [9] or during wartime [10]. It was initially proposed that fWHR is a sexually dimorphic trait [11], although this has not been confirmed in subsequent studies [12,13]. Nevertheless, intrasexual variation of fWHR in men is related to levels of sex hormones [14]. Testosterone influences growth trajectories of craniofacial shape during puberty [15] resulting in higher fWHR in individuals with higher testosterone levels [14] and higher levels of testosterone are also correlated with aggressive behaviour [16].

Several recent studies have suggested that the proposed link between fWHR and aggression might be an epiphenomenon of body size. For example, studies have demonstrated that body weight is a better predictor of aggression than fWHR [17] and that BMI is a better predictor of sport performance [18]. It has been further shown that variation in body dimensions such as weight (or BMI) affect the size of the face and dimensions of morphological traits including fWHR [19]. This strongly suggests that studies testing the potential association between fWHR and psychological characteristics should control for the effect of confounding morphological variables such as body size.

Here we tested whether variation in fWHR is associated with 1) perception of aggressiveness and fighting ability, and 2) actual fighting performance, while controlling for the effects of body height and weight. For this purpose, we used data from a sample of professional Mixed Martial Arts (MMA) fighters. We compared measures of fWHR with perceptions of fighters' aggressiveness and fighting ability, judged by independent raters from the fighters' facial photographs, as well as data on actual fighting performance.

Material and methods

i) Stimuli

The set of stimuli consisted of 146 portrait photographs of UFC MMA fighters available from http://www.ufc.com (for details see [20]). For each fighter, data on age (M = 29.77 years, SD = 4.6), height (M = 179.5, SD = 8), weight (M = 79.08, SD = 14.55), and number of fights (M = 8.78, SD = 7.02) and wins (M = 5.86, SD = 5.19) in the UFC were obtained. To account for varying numbers of fights among fighters, we computed fighting performance as the proportion of wins relative to the total number of fights.

i) Facial width-to-height ratio

Each fighter's bizygomatic width and distance between the upper lip and brow [6,15] was independently measured using GIMP 2.8 (GNU Image Manipulation Program). This was done twice (by VT and JF) to assess inter-rater reliability; intra-class correlation was high for both bizygomatic width ($r = 0.947$, $p < 0.001$, N = 146) and upper facial height ($r = 0.835$, $p < 0.001$, N = 146). The fWHR ratio was calculated by dividing the width by the height.

ii) Participants and ratings

618 individuals from the Czech Republic (216 men, M = 26.98 years, SD = 6.35; 402 women, M = 26.18 years, SD = 6.22) rated photographs of fighters for perceived aggressiveness. A further 278 (98 men, M = 28.31 years, SD = 9.99; 180 women, M = 27.1 years, SD = 7.52) rated the same photographs for perceived fighting ability (for details see [20]). Each participant's ratings were converted to *z* scores to account for differences in scale use, and a mean standardized score was calculated for each fighter. Ratings of male and female raters were highly correlated for both aggressiveness ($r = 0.933$, $p < 0.001$, N = 146) and fighting ability ($r = 0.946$, $p < 0.001$, N = 146), so we analysed the ratings of both sexes together.

iii) Statistical analysis

As fighters' weight, height and fighting performance were not normally distributed (Kolmogorov-Smirnov tests), associations between bivariate variables were assessed using two-tailed Kendall's correlations. The effect of fWHR on other measures was also tested by general linear models (GLM) with fighter's fWHR, height and weight as covariates. The covariates were added in the model only if either or both of the body characteristics were found to be significantly associated with the relevant measure. Effect sizes were expressed by partial η^2. Data were analysed using SPSS 20.

Results

i) Perceived aggressiveness and fighting ability

First, we found significant positive correlations between fWHR and fighter's height ($\tau = 0.171$, $p = 0.003$, N = 146) and weight ($\tau = 0.210$, $p < 0.001$, N = 146).

Perceived aggressiveness was positively correlated with fighter's fWHR ($\tau = 0.161$, $p = 0.004$, N = 146) and weight ($\tau = 0.189$, $p = 0.002$, N = 146). In contrast, fighter's height was not significantly correlated with perceived aggressiveness ($\tau = 0.08$, $p = 0.171$, N = 146). A GLM including fWHR and fighter's weight revealed that perceived aggressiveness was significantly and independently influenced by both fWHR ($F_{(1, 143)} = 7.108$, $p = 0.009$, $\eta\ 2 = 0.047$) and weight ($F_{(1, 143)} = 6.335$, $p = 0.013$, $\eta^2 = 0.042$).

Similarly, perceived fighting ability was positively correlated with fWHR (τ = 0.157, p = 0.005, N = 146) and fighter's weight (τ = 0.153, p = 0.01, N = 146) but not with fighter's height (τ = 0.072, p = 0.215, N = 146). Therefore, fWHR and fighter's weight were added as covariates in the GLM. Here, however, GLM results showed that perceived fighting ability was predicted by weight ($F_{(1, 143)}$ = 4.018, p = 0.047, η^2 = 0.027) but not by fWHR ($F_{(1, 143)}$ = 2.649, p = 0.106, η^2 = 0.018).

ii) Fighting performance

We first tested for potential associations between fighting performance and fighter's body size, but found no significant correlations between fighting performance and either fighter's height (τ = 0.021, p = 0.73, N = 146) or weight (τ = 0.03, p = 0.625, N = 146). However, fWHR was positively correlated with fighting performance (τ = 0.114, p = 0.046, N = 146).

Discussion

In a sample of professional MMA fighters, we found a positive association between perceived aggressiveness and fWHR and this effect was independent of body weight. In contrast, perceived fighting ability was significantly predicted only by body weight, but not fWHR. Moreover, actual fighting performance was associated with fWHR and this association was independent of any effects of body size.

Previous studies have indicated a relationship between fWHR and sport performance [7] or aggression [4,5]. However, from these results it was not possible to conclude whether fWHR is directly associated with these characteristics or whether it is an epiphenomenon of another morphological traits such as body size [17,18]. Our results suggest that fWHR, but not body height and weight, predicts fighting performance in our sample. This is not to say that body weight is irrelevant, because MMA fights take place between fighters in specified weight categories [see 20]. Further research is therefore needed to test possible interactions between fWHR, body weight and fighting performance in other samples. Our results indicate that fWHR is a predictor of outcome at least when competitors are relatively matched for weight. Interestingly, we also found no significant effect of height on fighting performance. Body height is correlated with upper arm length, which could provide an advantage of longer reach and higher striking force [21]. However, this effect appears to be relatively minor, at least among professional fighters.

In agreement with previous findings [17], we also found that fWHR and weight independently contribute to the perception of facial aggressiveness. In contrast, perceived fighting ability was predicted solely by body weight. Based on our findings, we suggest that the assessment of potential opponents acts on multiple dimensions. The first step, a 'fight or flight' decision, might depend predominantly on the overall size of the opponent, as suggested in our ratings of fighting ability. However, when the rivals are of roughly equal size, a further level of assessment takes place which is related to the perception of aggressiveness, affected by fWHR, as well as other facial traits [20].

To conclude, in a set of professional fighters we found positive associations between fWHR and fighting performance and these associations were not affected by body height and weight. Further, perception of aggressiveness was significantly associated with fWHR, independently of the effect of the weight. This suggests that human perception may have been selected to be attentive to cues related to variation in the propensity for fighting ability and aggression. Morphological characteristics, such as facial width, may reflect signals as suggested by some authors [5,22]. However, there are a number of criteria for the definition of biological signals, including that the trait was selected specifically for the purpose of communication [23], and more research is needed to determine if fWHR fits the criteria of a signal. Our data do support the notion that fWHR can act as a cue to fighting ability and so play an important role in intra-sexual selection.

Acknowledgements

VT and JF are supported by the Charles University Grant Agency grant GAUK 695512, KK and JH are supported by Czech Grant Agency grant GACR P407/11/1464, and Charles University Research Centre UNCE 204004.

References

1. Stirrat, M. R. & Perrett, D. I. 2010 Valid facial cues to cooperation and trust: male facial width and trustworthiness. *Psychol. Sci.* **21**, 349–54. (doi:10.1177/0956797610362647)

2. Haselhuhn, M. P. & Wong, E. M. 2012 Bad to the bone: facial structure predicts unethical behaviour. *Proc. Biol. Sci.* **279**, 571–6. (doi:10.1098/rspb.2011.1193)

3. Short, L. A., Mondloch, C. J., McCormick, C. M., Carré, J. M., Ma, R., Fu, G. & Lee, K. 2012 Detection of Propensity for Aggression based on Facial Structure Irrespective of Face Race. *Evol. Hum. Behav.* **33**, 121–129. (doi:10.1016/j.evolhumbehav.2011.07.002)

4. Lefevre, C. E. & Lewis, G. J. 2013 Perceiving Aggression from Facial Structure: Further Evidence for a Positive Association with Facial Width-to-Height Ratio and Masculinity, but not for Moderation by Self-Reported Dominance. *Eur. J. Pers.* (doi:10.1002/per.1942)

5. Carré, J. M. & McCormick, C. M. 2008 In your face: facial metrics predict aggressive behaviour in the laboratory and in varsity and professional hockey players. *Proc. R. Soc. B-Biological Sci.* **275**, 2651–2656. (doi:10.1098/rspb.2008.0873)

6. Carré, J. M., McCormick, C. M. & Mondloch, C. J. 2009 Facial structure is a reliable cue of aggressive behavior. *Psychol. Sci.* **20**, 1194–8. (doi:10.1111/j.1467-9280.2009.02423.x)

7. Tsujimura, H. & Banissy, M. J. 2013 Human face structure correlates with professional baseball performance: insights from professional Japanese baseball players. *Biol. Lett.* **9**, 20130140. (doi:10.1098/rsbl.2013.0140)

8. Windhager, S., Schaefer, K. & Fink, B. 2011 Geometric morphometrics of male facial shape in relation to physical strength and perceived attractiveness, dominance, and masculinity. *Am. J. Hum. Biol.* **23**, 805–14. (doi:10.1002/ajhb.21219)

9. Stirrat, M. R., Stulp, G. & Pollet, T. V. 2012 Male facial width is associated with death by contact violence: narrow-faced males are more likely to die from contact violence. *Evol. Hum. Behav.* **33**, 551–556. (doi:10.1016/j.evolhumbehav.2012.02.002)

10. Loehr, J. & O'Hara, R. B. 2013 Facial morphology predicts male fitness and rank but not survival in Second World War Finnish soldiers. *Biol. Lett.* **9**, 20130049. (doi:10.1098/rsbl.2013.0049)

11. Weston, E. M., Friday, A. E. & Lio, P. 2007 Biometric Evidence that Sexual Selection Has Shaped the Hominin Face. *PLoS One* **2**. (doi:10.1371/journal.pone.0000710)

12. Özener, B. 2011 Facial width-to-height ratio in a Turkish population is not sexually dimorphic and is unrelated to aggressive behavior. *Evol. Hum. Behav.* (doi:10.1016/j.evolhumbehav.2011.08.001)

13. Lefevre, C. E., Lewis, G. J., Bates, T. C., Dzhelyova, M., Coetzee, V., Deary, I. J. & Perrett, D. I. 2012 No evidence for sexual dimorphism of facial width-to-height ratio in four large adult samples. *Evol. Hum. Behav.* **33**, 1–5. (doi:10.1016/j.evolhumbehav.2012.03.002)

14. Lefevre, C. E., Lewis, G. J., Perrett, D. I. & Penke, L. 2013 Telling facial metrics: facial width is associated with testosterone levels in men. *Evol. Hum. Behav.* **34**, 273–279. (doi:10.1016/j.evolhumbehav.2013.03.005)

15. Verdonck, A., Gaethofs, M., Carels, C. & de Zegher, F. 1999 Effect of low-dose testosterone treatment on craniofacial growth in boys with delayed puberty. *Eur. J. Orthod.* **21**, 137–143. (doi:10.1093/ejo/21.2.137)

16. Archer, J. 2006 Testosterone and human aggression: an evaluation of the challenge hypothesis. *Neurosci. Biobehav. Rev.* **30**, 319–45. (doi:10.1016/j.neubiorev.2004.12.007)

17. Deaner, R. O., Goetz, S. M. M., Shattuck, K. & Schnotala, T. 2012 Body weight, not facial width-to-height ratio, predicts aggression in pro hockey players. *J. Res. Pers.* **46**, 235–238. (doi:10.1016/j.jrp.2012.01.005)

18. Mayew, W. J. 2013 Reassessing the association between facial structure and baseball performance: a comment on Tsujimura & Banissy (2013). *Biol. Lett.* **9**, 20130538. (doi:10.1098/rsbl.2013.0538)

19. Coetzee, V., Chen, J., Perrett, D. I. & Stephen, I. D. 2010 Deciphering faces: Quantifiable visual cues to weight. *Perception* **39**, 51–61. (doi:10.1068/p6560)

20. Třebický, V., Havlíček, J., Roberts, S. C., Little, A. C. & Kleisner, K. 2013 Perceived aggressiveness predicts fighting performance in mixed-martial-arts fighters. *Psychol. Sci.* **24**, 1664–72. (doi:10.1177/0956797613477117)

21. Carrier, D. R. 2011 The advantage of standing up to fight and the evolution of habitual bipedalism in hominins. *PLoS One* **6**, e19630. (doi:10.1371/journal.pone.0019630)

22. McCormick, C. M., Mondloch, C. J., Carre, J. M. & Short, L. 2010 The Facial Width-to-Height Ratio as a Basis for Estimating Aggression from Emotionally Neutral Faces. *J. Vis.* **10**, 599–599. (doi:10.1167/10.7.599)

23. Maynard-Smith, J. & Harper, D. G. C. 2003 *Animal signals*. Oxford: Oxford University Press, USA.